Research Note

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IS SAGEBRUSH SEED RESIDUAL IN THE SOIL OF BURNS OR IS IT WIND-BORNE?

Walter F. Mueggler
Division of Range Management Research

Establishment of thick stands of big sagebrush (Artemisia tridentata) seedlings the year following planned burning of sagebrush-grass range sometimes occurs despite all known precautions. When such establishment does occur, the benefits obtained from burning are relatively short-lived. Apparently there are "good" sagebrush reproduction years when seedlings will be present on the best of planned burns, and "poor" reproduction years when such burns will be relatively free of sagebrush seedlings. If it were possible to predict the type of sagebrush reproduction year, burning could be practiced only in those years when reproduction could be expected to be at a minimum and the risk of immediate reestablishment of a stand of big sagebrush could be avoided.

As an initial step in the solution of this problem, it is necessary to determine the immediate source of the seed which gives rise to sagebrush seedlings on the burned-over areas. This report presents various exploratory studies on this phase conducted since 1951 at the Upper Snake River Experimental Range at the U. S. Sheep Experiment Station near Dubois, Idaho. All of the work was designed to determine whether such seed originates from adjacent unburned areas and is deposited on the burned area after the fire, whether the seed is residual in the soil and remains viable despite the fire, or whether the seedlings arise from a combination of transported and residual seed.

Studies were conducted over a period of years on several planned and accidental burns. Methods of study on each successive burn varied to make use of ideas obtained from the preceding work. To simplify presentation, the data from each burn are treated separately. None of the evidence collected to date is convincing by itself, but when taken as a whole the data do indicate with some reliability the source of the seed causing such sagebrush reproduction.

1947 BURN

In 1951 an attempt was made to determine if sagebrush plants were distributed in a pattern that could be related to wind distribution of seed. A transect of plots was established in the general direction of the prevailing wind across a 1,000-acre area burned in 1947 at the U. S. Sheep Experiment Station. The wind was predominantly from the southwest and southeast with an occasional high north wind during the months of greatest seed dissemination, October and November. Sagebrush plants were counted on plots each encompassing 9.6 square feet at 50-foot intervals on a transect bearing NNE for a distance of 10,000 feet to the opposite edge of the burn. The data obtained are summarized in figure 1 by 500-foot intervals, with each class representing ten sample plots. Most of the sagebrush plants on this area became established the first year after the burn. The current year seedlings were not counted.

There is no clear-cut evidence of a pattern that could be attributed to wind-borne seed. However, the graph might possibly indicate a greater consistency of high sagebrush classes near the south quarter of the burn than in the rest. Plant numbers on the 10 plots within each 500-foot interval closest to the edge of the burn did not show a pattern of wind distribution attributable to nearness of an unburned seed source. The reason for the extreme variation in the three intervals between 3,500 and 2,000 feet north is not clear. It is not caused by a very few plots with extreme variation, for numbers are rather consistent in all plots for these classes. Although there were occasional small clumps of unburned sagebrush on the area, these were by no means frequent and it is not believed these were responsible for the erratic distribution. Possible explanations include effect of wind eddying, more favorable local site, or a greater amount of residual seed in soil, none of which have been determined.

The above evidence does not strongly support the theory of wind-borne seed over that of residual seed, nor does it severely detract from such a possibility. However, if the slight tendency toward greater numbers near the edge is real, it is probably the result of wind distribution, thus indicating that wind does have at least some influence.

1951 BURN

A series of paired covered and bare plots was established on a 400-acre area near Spencer, Idaho, that was accidentally burned in July 1951. This area had been subject to severe overgrazing and trailing by sheep and consequently contained little but big sagebrush. Three transects of seven permanent paired plots each were established in the early fall of 1951; one transect began at the north side, one at the east side, and one at the southwest side of the burn--all ran from the edge of the

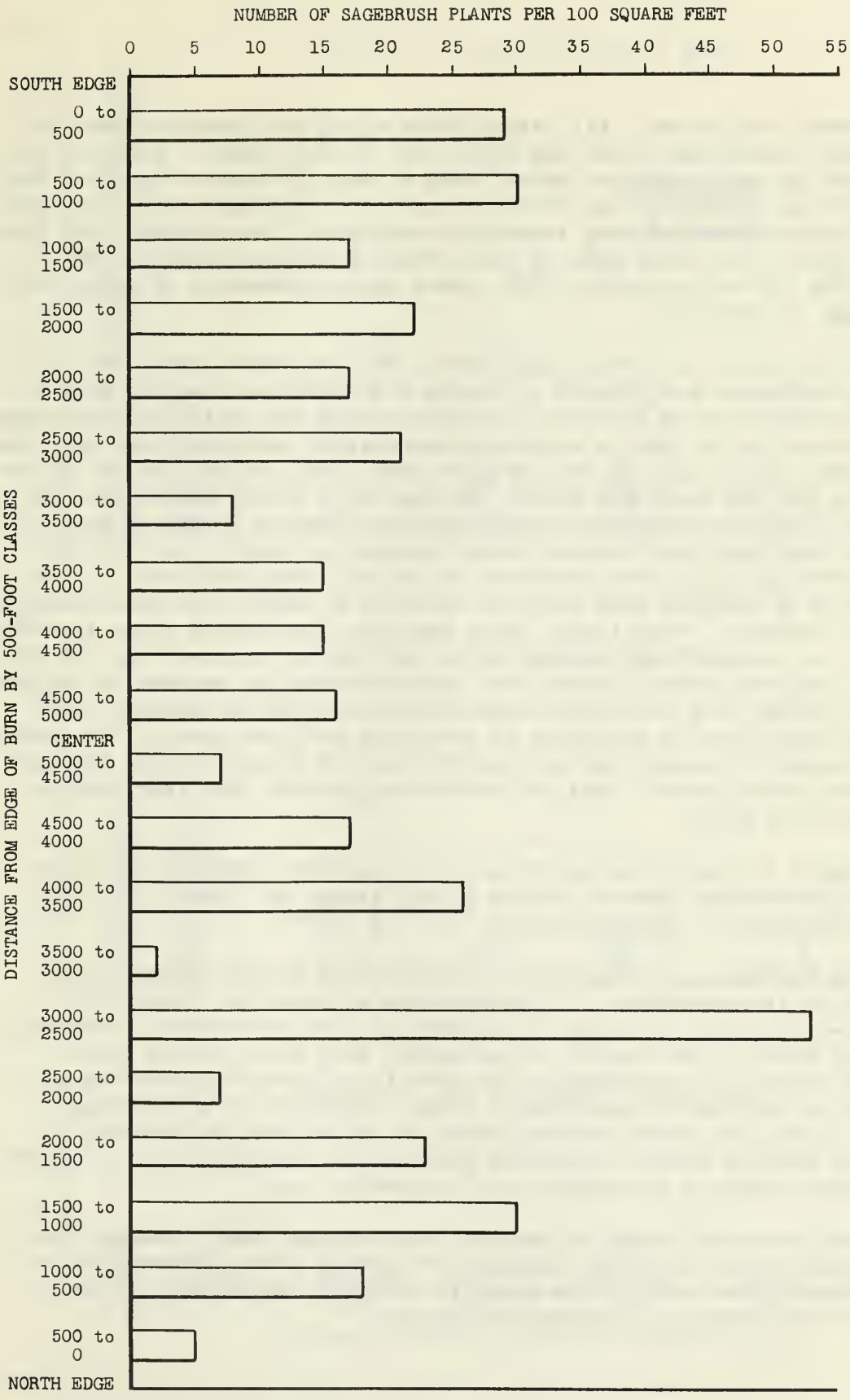

Figure 1.--Numbers of sagebrush plants by distance classes on a transect across the 1947 burn. Each class represents a 10-plot section.

burn toward the center. All paired plots along the transects were 100 feet apart except the first two which were 50 feet apart. A paired plot consisted of two contiguous areas, each a 36-by 67-inch rectangle. One of the areas on each paired plot was covered by a double layer of cheesecloth in an attempt to keep wind-borne seed off. The adjacent bare plot was to serve as a check area on which wind-borne seed would be free to land. The following spring, 1952, there was an abundance of sagebrush seedlings on the burn.

To determine if a wind distribution pattern exists here, the plot data by transects are related in figure 2 to distance from the seed source at the edge of the burn. Transects from the north and east sides of the burn tend to show a greater occurrence of seedlings near the edges than toward the middle of the unburned area. This appears to be the case not only for the uncovered plots, but also to a lesser degree for the covered plots. It should be noted that the distance between plots here is much less than that between class centers in figure 1 for the 1947 burn. Although this burn is within 10 miles of the 1947 burn, it is located in a foothill area near the mouth of a canyon, and wind direction is more variable. Very likely there are more down-canyon winds from the north. In viewing these transects, as well as the transects on the 1947 burn, it appears that if there is a wind-distribution pattern it is generally limited to a peripheral area fairly close to an unburned seed source. But since an abundance of seedlings occurred even in the center of the burns, it seems likely, from the lack of a distribution pattern in these central areas, that the seedlings occurred here from seed residual on the area.

Figure 2 also indicates the generally greater abundance of seedlings on uncovered than on covered plots, except on transect 3 which has markedly fewer total seedlings than the others.

The tendency for the covered plots to show a wind distribution pattern is disconcerting. If this pattern actually is attributable to wind-borne seed, it could be assumed that the cheesecloth coverings were not entirely successful in preventing seed from landing on the covered plots. It is possible also that the cheesecloth covering so changed the microenvironment as to promote germination of existing seed. In view of these possibilities, it is believed differences in seedling numbers between uncovered and covered plots are not indicative of relative amounts of residual and wind-borne seed.

Thus seedling counts on the 1951 burn suggest that although wind-borne seed occurred in a peripheral area within a few hundred feet of the unburned seed source, the majority of seedlings on the burn developed from viable seed stored in the soil.

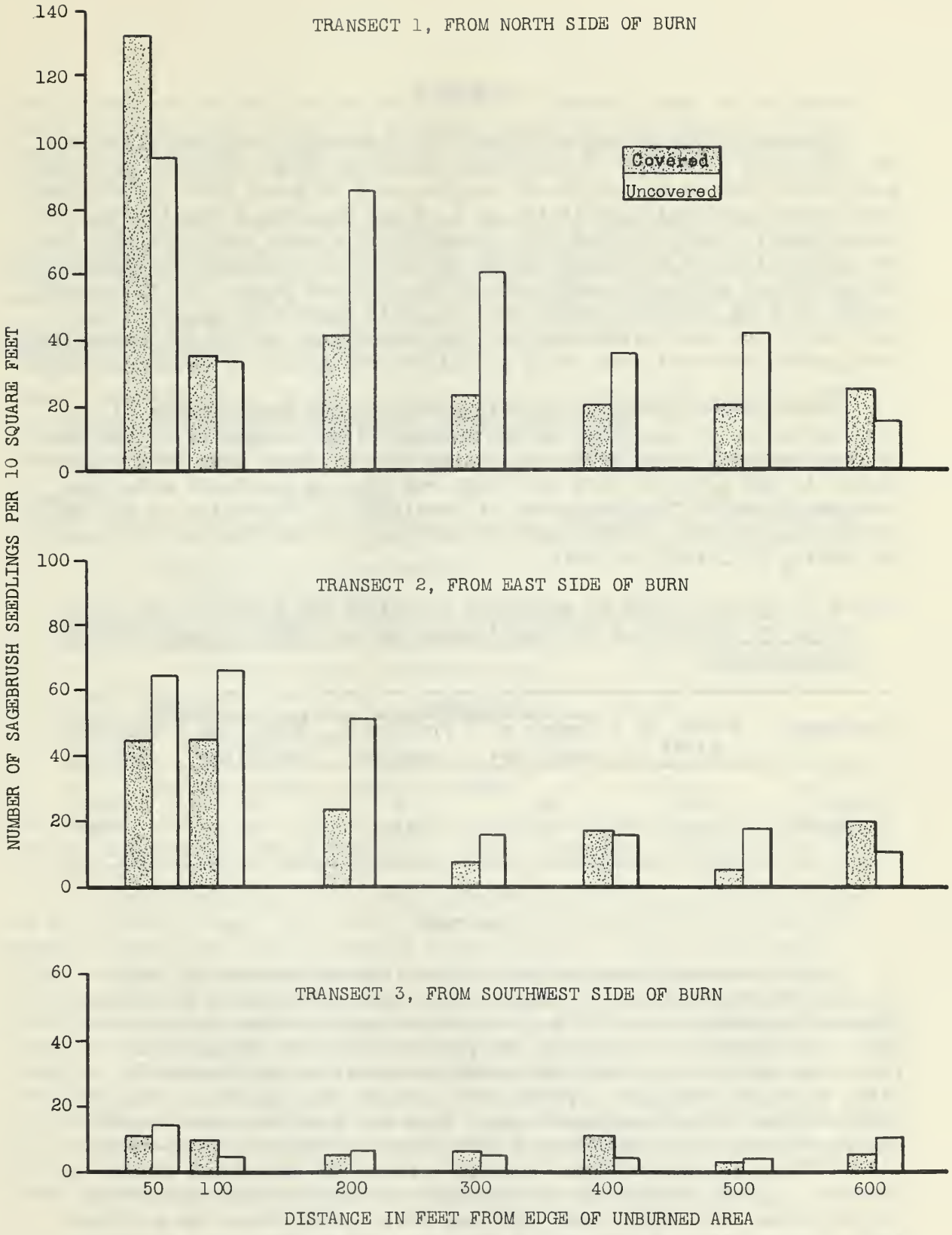

Figure 2.--Numbers of sagebrush seedlings on covered and uncovered plots on the 1951 burn. Plots are located on three different transects starting at different edges and extending into burn.

1952 BURN

Because of the uncertainty that the cheesecloth-covered plots on the 1951 burn were free of introduced seed, an effort was made to select a covering that would positively exclude seed on small plots established on a 30-acre planned burn at the U. S. Sheep Experiment Station the following year. Again covered and uncovered plots were used, but this time the possibility of seed penetrating the cover was virtually eliminated by using 12-inch garden hot-caps made of treated wax paper. Fifty covered plots, each 78.5 square inches in area, with comparable adjacent uncovered plots, were established on the burned area and 25 were established on a nearby unburned area prior to fall dissemination of sagebrush seed.

Although the number of seedlings counted was small (table 1), the very existence of seedlings on the covered plots, supported by frequency of occurrence, is a reliable indication that at least some seed remained viable in the soil and that this seed was able to germinate after the area was burned. The low number of seedlings is attributed to the small sample size as well as to a general scarcity of seedlings on this area the spring following the burn.

Table 1.--Total number of sagebrush seedlings and frequency of occurrence on covered and uncovered plots on the 1952 burn and adjacent unburned area

Treatment	Number of plots	Uncovered		Covered	
		Number of seedlings	Frequency percent	Number of seedlings	Frequency percent
Burned	50	9	8	5	10
Unburned	25	3	12	9	36

1953 BURN

Four transects, representing four different treatments, with 25 plots each containing 25 square feet, were established on a large planned burn made at the U. S. Sheep Experiment Station the fall of 1953. An unburned seed source was present less than 50 yards to the southeast and another about 500 yards southwest of the transects. After the burn, transect 1 plots were scalped to a depth of 1½ to 2½ inches prior to seed dissemination. This was done to remove residual sagebrush seed, thus providing a "free" bed for possible wind-borne seed. The soil removed from transect 1 plots was saved and placed on transect 2 plots after they were scalped early the following spring to remove any wind-borne seed that may have landed there the previous fall. These latter plots should then have had on them only sagebrush

seed stored in the soil prior to burning. Transect 3 was an untreated check with both wind-borne and residual seed, and transect 4, scalped early in the spring, also served as a check on which theoretically no seedlings should have occurred.

Unfortunately very few sagebrush seedlings appeared anywhere on the burn the spring of 1954 and there were correspondingly few on the study transects (table 2). Only three seedlings were present on the entire 625 square feet of untreated check area. Consequently this work yielded no information on sagebrush. It does, however, exemplify a poor sagebrush reproduction year on a planned burn.

Table 2.--Numbers of sagebrush and bitterbrush seedlings on four different scalped-plot treatments on the 1953 burn

Transect	Treatment	Total seedlings on 625 sq. ft.	
		Sagebrush	Bitterbrush
1	Fall-scalped after burning (wind-borne seed)	1	0
2	Spring-scalped and covered with transect 1 soil (residual seed)	0	1/ 25
3	Nonscalped check (wind-borne and residual seed)	3	2
4	Spring-scalped only (no seed)	1	0

1/ All singles but two groups of 2. Plot frequency of 44 percent.

It is interesting to note the occurrence of bitterbrush seedlings on the treated areas. The study site had an abundance of bitterbrush prior to the burn, thus providing a seed source. Although few seedlings occurred on the untreated check, only two in 625 square feet, 25 were present on the 625 square feet of sample area that was spring scalped and covered with soil from the fall-scalped area. These seedlings occurred on almost half the plots of transect 2, mostly as singles. The seedlings may have originated either from buried seed being brought to the surface by the soil transfer and disturbance, or by viable seed that had fallen on the surface being mixed and covered with mineral soil. In either event soil disturbance appears to have been a factor in germination. But the important point is that at least some bitterbrush seed survived the burn and produced new plants.

1954 BURN

In 1954 the above study was repeated at a large accidental burn in a foothill area west of Spencer, Idaho. Two sets of four 10-plot transects, with each plot containing 25 square feet, were used. Each set was located on a separate site. Both sites had been covered with old, dense stands of big sagebrush prior to burning. An unburned seed source was present within 200 yards of both sites. Treatment of each of the four transects per site was the same as in 1953.

Site 1 was on an extremely intense portion of the burn; sagebrush stumps were burned to and often below ground level. Very few seedlings occurred the following year on sample plots on this area. However, a small number of seedlings appeared on the less intense burn of site 2 (table 3). Apparently fires can be of sufficient intensity to kill much of the sagebrush seed stored in the soil.

Table 3.--Number of sagebrush seedlings and frequency of occurrence on four scalped-plot treatments on the 1954 burn, Site 2

Transect	Treatment	Number per 100 sq.ft.	Frequency percent (10 plots)
1	Fall-scalped after burning (wind-borne seed)	1.2	20
2	Spring-scalped and covered with transect 1 soil (residual seed)	3.2	60
3	Nonscalped check (wind-borne and residual seed)	29.2	80
4	Spring-scalped only (no seed)	1.2	20

Although the reliability of the data is limited by the small number of seedlings, certain conclusions are suggested. The like amount of seedlings on transects 1 and 4 indicates the absence of wind-borne seed. The occurrence of more seedlings, and especially greater frequency, on transect 2 plots than on transects 1 and 4 plots indicates the presence of residual seed. The greatest number of seedlings on the untreated check, transect 3, suggests that soil disturbance on transect 2 may have hindered germination.

The seedlings occurring on the area encompassed by the sample, then, appear to have originated from residual seed unaffected by the fire. There was no evidence of wind-borne seed.

GERMINATION TRIALS

In addition to the above field studies, soil samples were collected on the 1951, 1952, and 1953 burns and adjacent unburned areas to test for the presence of viable sagebrush seed by greenhouse germination trials. All samples were collected after the respective burns, but prior to seed dissemination on the adjacent unburned areas. About 180 separate 2- to 3-cubic-inch samples were involved in these tests. The individual samples were small (a 2-cubic-inch sample represents only an 8-square-inch area of a 1/4-inch soil layer) with consequent limitations of possible number of seeds per sample.

The results of these germination trials are presented in table 4. These tests yielded positive evidence that sagebrush seed persists in the soil for at least one year and that such seed remains viable in the surface 1/2-inch layer despite burning. It is also clear that artificially stored sagebrush seed can remain viable in soil samples for at least 3 years, since the 1951 seed germinated readily in the greenhouse in the spring of 1954. In addition these data might be interpreted to indicate the following: burning kills about three-fourths of the seed in the surface 1/4-inch layer; burning has no effect on seed below the 1/4-inch layer; about three times as much seed occurs in the surface mineral soil as in the surface ash layer; no live seed is present in drifted ashes. However, such conclusions can be only tentative in view of the limited number of seedlings obtained.

CONCLUSIONS

It is concluded from the studies to date that sagebrush seedlings on burned-over areas arise both from seed introduced into the area from an adjacent unburned seed source and from seed stored in the soil that remains viable after burning. These studies indicate that wind-borne seed is restricted to areas fairly near the unburned seed source. It seems probable that residual seed is by far the greater source of seedlings on the major portion of large burned-over areas.

Table 4.--Numbers and frequency of occurrence of sagebrush seedlings grown from soil samples collected on areas burned in 1951, 1952, and 1953

Source	Number of samples	Total number of seedlings	Number of seedlings per 10 cubic inches soil	Frequency (percent)
1951				
BURNED				
0-¼-inch depth	25	13	2.60	24
½-1-inch depth	24	5	1.00	21
UNBURNED				
Under shrubs:				
0-¼-inch depth	10	24	12.00	80
½-1-inch depth	10	4	2.00	20
In openings:				
0-¼-inch depth	10	21	10.50	60
½-1-inch depth	10	1	.50	10
1952				
BURNED				
0-¼-inch depth	10	0	0	0
¼-½-inch depth	10	4	1.34	20
UNBURNED CHECK				
0-¼-inch depth	10	1	.34	10
¼-½-inch depth	10	4	1.34	20
1953				
BURNED				
Mineral soil layer	20	6	.99	25
Residual ash layer	20	2	.33	10
Drifted ash layer	10	0	0	0